

What is claimed is:

1. In a process for the gas phase polymerization of ethylene and from 0 to 20 weight % of one or more C₄₋₈ copolymerizable alpha olefin monomers in the presence of a supported Ziegler-Natta catalyst co-catalyzed with a co-catalyst selected from the group consisting of tri C₂₋₆ alkyl aluminum, alkyl aluminum halides and mixtures thereof, the improvement of controlling the feed of said co-catalyst to the reactor to provide from 10 to 50 ppm of aluminum from the co-catalyst based on the polymer production rate provided that the molar ratio of total Al from the catalyst and co-catalyst:Ti from the catalyst is not less than 25:1.
2. The process according to claim 1, wherein the co-catalyst is used in an amount to provide from 10 to 40 ppm of aluminum from the co-catalyst based on the polymer production rate.
3. The process according to claim 2, wherein the Ziegler-Natta catalyst comprises an aluminum compound of the formula $Al((O)_aR^1)_bCl_{3-b}$ wherein a is either 0 or 1, b is an integer from 1 to 3, R¹ is a C₁₋₁₀ alkyl radical, a titanium compound of the formula $Ti(OR^2)_cX_{d-c}$ wherein R² is selected from the group consisting of a C₁₋₄ alkyl radical, a C₆₋₁₀ aromatic radical, and a radical of the formula -COR³ wherein R³ is selected from the group consisting of a C₁₋₄ alkyl radical and a C₆₋₁₀ aromatic radical, X is selected from the group consisting of a chlorine atom and a bromine atom, c is 0 or an integer up to 4 and d is an integer up to 4 and the sum of c+d is the valence of the Ti atom; a magnesium compound of the formula

$(R^5)_eMg X_{2-e}$ wherein each R^5 is independently a C_{1-4} alkyl radical and e is 0, 1 or 2; an alkyl halide selected from the group consisting of CCl_4 or a C_{3-6} secondary or tertiary alkyl halide and optionally an electron donor, said catalyst having a molar ratio of Al to Ti from 1:1 to 15:1; a molar ratio of Mg:Ti from 1:1 to 20:1; a molar ratio of halide from the alkyl halide to Mg from 1:1 to 8:1; a molar ratio of electron donor to Ti from 0:1 to 15:1 and the titanium is present in the catalyst in an amount from 0.25 to 1.25 weight % inclusive of the support.

4. The process according to claim 3, wherein in the catalyst the molar ratio of Al:Ti is from 4:1 to 10:1.

5. The process according to claim 4, wherein in the catalyst the molar ratio of Mg:Ti is from 2:1 to 12:1.

6. The process according to claim 5, wherein in the catalyst the titanium component is selected from the group consisting of $TiCl_3$, $TiCl_4$, $Ti(OC_4H_9)Cl_3$, $Ti(OCOCH_3)Cl_3$ and $Ti(OCOC_6H_5)Cl_3$.

7. The process according to claim 6, wherein in the catalyst the aluminum compound is selected from the group consisting of trimethyl aluminum, triethyl aluminum, tri iso-butyl aluminum, tri-n-hexyl aluminum, tri-octyl aluminum, diethyl aluminum chloride and mixtures thereof.

8. The process according to claim 7, wherein in the catalyst the magnesium compound is selected from the group consisting of

magnesium chloride, dibutyl magnesium and butyl ethyl magnesium, provided if the magnesium compound is other than magnesium chloride the alkyl halide is present in an amount to provide a molar ratio of halogen:Mg from 1.5:1 to 6:1.

9. The process according to claim 8, wherein in the catalyst the alkyl halide is a C₃₋₆ secondary or tertiary alkyl chloride.

10. The process according to claim 9, wherein the electron donor is selected from the group consisting of C₃₋₁₈ linear or cyclic aliphatic or aromatic ethers, ketones, esters, aldehydes, amides, nitriles, amines, phosphines or siloxanes.

11. The process according to claim 10, wherein the support is an inorganic support having an average particle size from about 10 to 150 microns, a surface area greater than 100 m²/g, a pore volume from about 0.3 to 5.0 ml/g, a surface hydroxyl content from about 0.1 to 5 mmol/g of support.

12. The process according to claim 11, wherein the electron donor is present in an amount to provide a molar ratio of electron donor to the titanium from 3:1 to 12:1.

13. The process according to claim 12, wherein the electron donor is selected from the group consisting diethyl ether, dipropyl ether, dibutyl

ether, tetrahydrofuran, acetone, ethyl benzoate, and diphenyl ether and mixtures thereof.

14. The process according to claim 13, wherein in the catalyst from 0 to 60 weight % of the aluminum compound of the formula $\text{Al}((\text{O})_a\text{R}^1)_b\text{Cl}_{3-b}$ wherein a is either 0 or 1, b is an integer from 1 to 3, R^1 is a C_{1-8} alkyl radical, is used to treat the support and the aluminum content on the support is included in the ratio of Al:Ti in the catalyst.

15. The process according to claim 14, wherein the remaining aluminum compound in the catalyst is added after the addition of the titanium compound.

16. The process according to claim 15, wherein the titanium compound is selected from the group consisting of TiCl_3 and TiCl_4 .

17. The process according to claim 16, wherein in the catalyst the Ti is present in an amount from 0.25 to 0.70 weight % inclusive of the support.

18. The process according to claim 17, wherein the co-catalyst is triethyl aluminum.

19. The process according to claim 17, wherein the co-catalyst is triisobutyl aluminum.

20. The process according to claim 17, wherein the co-catalyst is tri-n-hexyl aluminum.

21. The process according to claim 18, wherein the comonomer is present in an amount from 0.5 to 16 weight % and is selected from the group consisting of butene, 4-methyl pentene, hexene, and a mixture thereof.

22. The process according to claim 21, wherein the comonomer is hexene and is present in an amount from 8 to 13 weight %.

23. The process according to claim 22, wherein the triethyl aluminum is used in an amount to provide from 16 to 31 ppm of aluminum.

24. The process according to claim 19, wherein the comonomer is present in an amount from 0.5 to 16 weight % and is selected from the group consisting of butene, 4-methyl pentene, hexene, and a mixture thereof.

25. The process according to claim 24, wherein the comonomer is hexene and is present in an amount from 8 to 13 weight %.

26. The process according to claim 25, wherein the tri-isobutyl aluminum is used in an amount to provide from 16 to 31 ppm of aluminum.

27. The process according to claim 20, wherein the comonomer is present in an amount from 0.5 to 16 weight % and is selected from the group consisting of butene, 4-methyl pentene, hexene, and a mixture thereof.
28. The process according to claim 27, wherein the comonomer is hexene and is present in an amount from 8 to 13 weight %.
29. The process according to claim 28, wherein the tri-n-hexyl aluminum is used in an amount to provide from 16 to 31 ppm of aluminum.
30. A process to control a gas phase polymerization of ethylene and from 0 to 20 weight % of one or more C₄₋₈ copolymerizable alpha olefin monomers in the presence of a supported Ziegler-Natta catalyst co-catalyzed with tri C₂₋₆ alkyl aluminum, comprising maintaining the molar ratio of total Al from the catalyst and co-catalyst:Ti from the catalyst from 25:1 to 80:1 and controlling the feed of said tri C₂₋₆ alkyl aluminum co-catalyst to the reactor to provide from 10 to 50 ppm of aluminum from the co-catalyst based on the polymer production rate.
31. The process according to claim 30, wherein the co-catalyst is used in an amount to provide from 10 to 40 ppm of aluminum from the co-catalyst based on the polymer production rate.
32. The process according to claim 31, wherein the Ziegler-Natta catalyst comprises an aluminum compound of the formula $\text{Al}((\text{O})_a\text{R}^1)_b\text{Cl}_{3-b}$

wherein a is either 0 or 1, b is an integer from 1 to 3, R¹ is a C₁₋₁₀ alkyl radical, a titanium compound of the formula Ti(OR²)_cX_{d-c} wherein R² is selected from the group consisting of a C₁₋₄ alkyl radical, a C₆₋₁₀ aromatic radical, and a radical of the formula -COR³ wherein R³ is selected from the group consisting of a C₁₋₄ alkyl radical and a C₆₋₁₀ aromatic radical, X is selected from the group consisting of a chlorine atom and a bromine atom, c is 0 or an integer up to 4 and d is an integer up to 4 and the sum of c+d is the valence of the Ti atom; a magnesium compound of the formula (R⁵)_eMg X_{2-e} wherein each R⁵ is independently a C₁₋₄ alkyl radical and e is 0, 1 or 2; an alkyl halide selected from the group consisting of CCl₄ or a C₃₋₆ secondary or tertiary alkyl halide and optionally an electron donor, said catalyst having a molar ratio of Al to Ti from 1:1 to 15:1; a molar ratio of Mg:Ti from 1:1 to 20:1; a molar ratio of halide from the alkyl halide to Mg from 1:1 to 8:1; a molar ratio of electron donor to Ti from 0:1 to 15:1 and the titanium is present in the catalyst in an amount from 0.25 to 1.25 weight % inclusive of the support.

33. The process according to claim 32, wherein in the catalyst the molar ratio of Al:Ti is from 4:1 to 10:1.

34. The process according to claim 33, wherein in the catalyst the molar ratio of Mg:Ti is from 2:1 to 12:1.

35. The process according to claim 34, wherein in the catalyst the titanium component is selected from the group consisting of TiCl₃, TiCl₄, Ti(OC₄H₉)Cl₃, Ti(OCOCH₃)Cl₃ and Ti(OCOC₆H₅)Cl₃.

36. The process according to claim 35, wherein in the catalyst the aluminum compound is selected from the group consisting of trimethyl aluminum, triethyl aluminum, tri iso-butyl aluminum, tri-n-hexyl aluminum, tri-octyl aluminum, diethyl aluminum chloride and mixtures thereof.

37. The process according to claim 36, wherein in the catalyst the magnesium compound is selected from the group consisting of magnesium chloride, dibutyl magnesium and butyl ethyl magnesium, provided if the magnesium compound is other than magnesium chloride the alkyl halide is present in an amount to provide a molar ratio of halogen:Mg from 1.5:1 to 6:1.

38. The process according to claim 37, wherein in the catalyst the alkyl halide is a C₃₋₆ secondary or tertiary alkyl chloride.

39. The process according to claim 38, wherein the electron donor is selected from the group consisting of C₃₋₁₈ linear or cyclic aliphatic or aromatic ethers, ketones, esters, aldehydes, amides, nitriles, amines, phosphines or siloxanes.

40. The process according to claim 39, wherein the support is an inorganic support having an average particle size from about 10 to 150 microns, a surface area greater than 100 m²/g, a pore volume from about 0.3 to 5.0 ml/g, a surface hydroxyl content from about 0.1 to 5 mmol/g of support.

41. The process according to claim 40, wherein the electron donor is present in an amount to provide a molar ratio of electron donor to the titanium from 3:1 to 12:1.

42. The process according to claim 41, wherein the electron donor is selected from the group consisting diethyl ether, dipropyl ether, dibutyl ether, tetrahydrofuran, acetone, ethyl benzoate, and diphenyl ether and mixtures thereof.

43. The process according to claim 42, wherein in the catalyst from 0 to 60 weight % of the aluminum compound of the formula $Al((O)_aR^1)_bCl_{3-b}$ wherein a is either 0 or 1, b is an integer from 1 to 3, R^1 is a C_{1-8} alkyl radical, is used to treat the support and the aluminum content on the support is included in the ratio of Al:Ti in the catalyst.

44. The process according to claim 43, wherein the remaining aluminum compound in the catalyst is added after the addition of the titanium compound.

45. The process according to claim 44, wherein the titanium compound is selected from the group consisting of $TiCl_3$ and $TiCl_4$.

46. The process according to claim 45, wherein in the catalyst the Ti is present in an amount from 0.25 to 0.70 weight % inclusive of the support.

47. The process according to claim 46, wherein the co-catalyst is triethyl aluminum.

48. The process according to claim 46, wherein the co-catalyst is triisobutyl aluminum.

49. The process according to claim 46, wherein the co-catalyst is tri-n-hexyl aluminum.

50. The process according to claim 47, wherein the comonomer is present in an amount from 0.5 to 16 weight % and is selected from the group consisting of butene, 4-methyl pentene, hexene, and a mixture thereof.

51. The process according to claim 50, wherein the comonomer is hexene and is present in an amount from 8 to 13 weight %.

52. The process according to claim 51, wherein the triethyl aluminum is used in an amount to provide from 16 to 31 ppm of aluminum.

53. The process according to claim 48, wherein the comonomer is present in an amount from 0.5 to 16 weight % and is selected from the group consisting of butene, 4-methyl pentene, hexene, and a mixture thereof.

54. The process according to claim 53, wherein the comonomer is hexene and is present in an amount from 8 to 13 weight %.

55. The process according to claim 54, wherein the tri-isobutyl aluminum is used in an amount to provide from 16 to 31 ppm of aluminum.

56. The process according to claim 49, wherein the comonomer is present in an amount from 0.5 to 16 weight % and is selected from the group consisting of butene, 4-methyl pentene, hexene, and a mixture thereof.

57. The process according to claim 56, wherein the comonomer is hexene and is present in an amount from 8 to 13 weight %.

58. The process according to claim 57, wherein the tri-n-hexyl aluminum is used in an amount to provide from 16 to 31 ppm of aluminum.